

ELECTRONIC FUNDAMENTALS

EXPERIMENT LESSON 40

TROUBLESHOOTING EXPERIMENTS IV



RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION OF AMERICA

HOME STUDY SCHOOL

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Experiment Lesson 40

INTRODUCTION

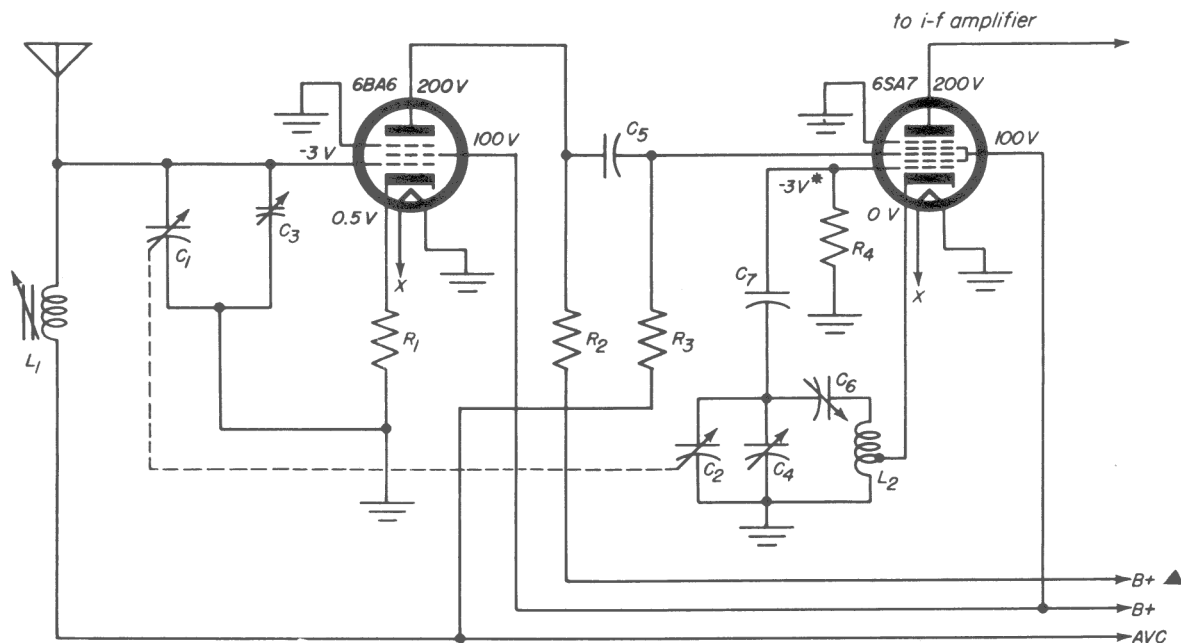
This Experiment Lesson, the last in the series of four troubleshooting lessons, will show you how to tell whether the r-f and converter sections of the receiver are operating properly, and how to quickly locate the trouble when they are not.

The r-f and converter sections are shown in Fig. 40-1, and their relationship to the complete receiver can be seen in the complete schematic diagram of Fig. 40-2.

The r-f amplifier serves to provide additional gain so that the receiver can perform well on weak signals. In many broadcast superheterodyne receivers, the r-f stage is omitted. In that case, the tuning circuit in the grid of the r-f amplifier is found in the

grid circuit of the converter stage. This tuned input circuit provides r-f selectivity to reduce image interference. It does *not* select the station; this is done by the oscillator frequency, in conjunction with the very selective i-f amplifiers.

Most modern superheterodyne broadcast receivers use a pentagrid converter, similar to the one used in this receiver. This tube performs a dual function. It generates the local oscillator signal, and it mixes the local oscillator signal with the incoming station signal. Occasionally, a receiver has separate mixer and oscillator tubes, but the troubleshooting procedure for such receivers is essentially the same. Since the highly selective i-f amplifiers pass signals only at the intermediate frequency, the oscillator must function or the receiver will not operate.



All voltages measured with moderately strong signal tuned in.

*Measured with tuning capacitor at maximum capacity setting.

Fig. 40-1

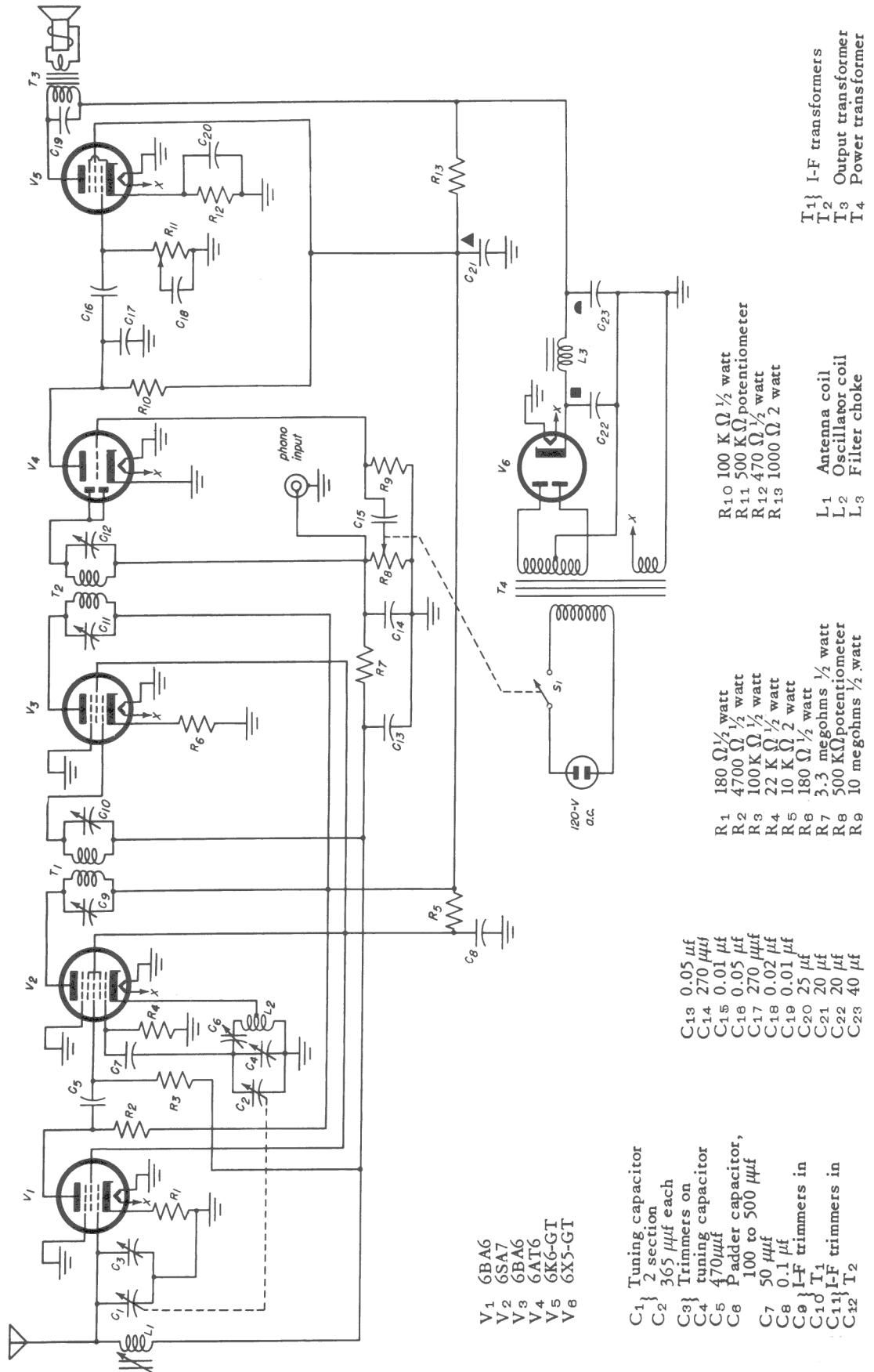


Fig. 40-2

EXPERIMENT 40-1

To learn the normal resistances for the converter and r-f amplifier stages.

Procedure.

Step 1. Turn the receiver off. Fill out Table A. Make the measurements called for in *Measurements* column and record your results in the *Resistance* column.

Discussion. The correctness of your resistance readings can be verified by examining Fig. 40-2, which shows the correct resistance values for all the components in this circuit. Note that the resistance across the tuning capacitor sections should be very high. In the case of the oscillator section, you should measure infinite ohms. In the case of the r-f section, a d-c path exists across the capacitor through the AVC circuit

and volume control back to the chassis; thus this reading is not infinite, but should be 4 megohms. If you measure much less than 4 megohms, you should suspect leakage in the AVC filter capacitors or in the tuning capacitor itself.

In some receivers, no AVC is applied to the grid of the first tube in the receiver, and the antenna coil is connected directly across the tuning capacitor. If it is necessary to check the tuning capacitor in such a circuit for shorts or leakage, the antenna coil must be disconnected.

The resistance range of antenna coils is usually about 5 to 50 ohms. However, the antenna coil resistance in this receiver is about 1 ohm. The resistance is low because the iron core enables the required inductance to be obtained with relatively few turns. Thus the core is an important part of this circuit, just

TABLE A -- RESISTANCE MEASUREMENTS

Converter-Oscillator		R-F Amplifier	
Measurement	Resistance (ohms)	Measurement	Resistance (ohms)
Signal grid of the converter tube to chassis		Control grid of r-f amplifier to chassis	
Signal grid of the converter tube to the AVC line		Control grid of r-f amplifier to AVC line	
Oscillator grid of converter tube to chassis		Screen grid of r-f amplifier to chassis	
Oscillator plate (pin 4) of converter tube to chassis		Cathode of r-f amplifier to chassis	
Converter plate to chassis		Plate of r-f amplifier to chassis	
Converter plate to B+ line		Plate of r-f amplifier to B+ line	
Cathode of converter tube to chassis		Suppressor grid of r-f amplifier to chassis	
Suppressor grid of converter tube to chassis		Across antenna coil terminals	
Stator lug, oscillator section of tuning capacitor to chassis			
Junction of C_6 and L_2 to chassis			

as much as the coil itself. If the core is cracked or broken, it may change the inductance sufficiently to prevent proper operation of the r-f tuning circuit. Therefore, the core itself should always be examined when the tuning coil is checked.

EXPERIMENT 40-2

To learn the normal voltages for the converter and r-f amplifier stages.

Procedure.

Step 1. Plug in the receiver and allow the tubes to warm up.

Step 2. Using the appropriate meter setup measure and record the following voltages listed in Table B.

TABLE B - VOLTAGE MEASUREMENTS

Measurements	Voltage (volts)
Converter-Oscillator	
Oscillator plate (pin 4)	125
Oscillator grid 10P	- .3
Converter signal grid 5	- .65
Converter plate 3	290
Converter cathode 8	0
R-F Amplifier	
Plate 3	290
Screen 4	125
Control grid T	- .35
Suppressor grid 5	0
Cathode 8	0

Discussion. Typical d-c voltages for this circuit are shown in Fig. 40-1.

The d-c voltage at the oscillator grid is an important troubleshooting measurement. This voltage of from about -5 to -15 volts is the signal-developed grid bias, and indicates that the oscillator is functioning. The grid bias usually varies as the receiver is tuned over the broadcast band, and may fall off at either the low end or high end, or both. The oscillator grid bias should always be checked over the entire band.

The voltages on the other electrodes of both tubes are similar to that of any other amplifier. The voltage across the cathode resistor of the r-f tube is an indication that current is flowing in the tube and is another valuable troubleshooting indication.

When you measure signal developed grid bias at the oscillator grid, or AVC voltage at the grid of the r-f amplifier, always use an isolating resistor to prevent the capacitance of the meter and meter leads from disturbing the circuit. Any large-value resistor (about 100,000 ohms or more), can be used. Insert it between the meter leads and the circuit to be tested. The meter deflection will be reduced due to the resistor, since the voltage being measured will divide between meter and isolating resistor according to their resistances. However, it is essential that the isolating resistor be used. Otherwise, connecting the meter to the oscillator grid without the resistor may cause the oscillator to stop operating. However, if the size of the resistor is equal to the resistance of the meter on a particular scale, the actual voltage present may be obtained by doubling the meter reading. Since the meter resistance is 20,000 ohms per volt, the total meter resistance on the 5 VDC scale is 100,000 ohms. If a 100,000-ohm resistor is used as the isolating resistor, the actual voltage present can be obtained by doubling the meter reading.

EXPERIMENT 40-3

To make dynamic checks of the converter stage.

Information. Because of the dual functions of the converter tube, there are two parts of

converter operation to be checked. The mixer section of the converter must be checked to see whether it is operating as an amplifier and is capable of passing and amplifying signals at the intermediate frequency of the receiver. The oscillator part of the converter must be checked to see whether it is oscillating and producing a local unmodulated signal for the heterodyne process. Only intermediate-frequency signals will pass through the selective i-f amplifiers, and an intermediate-frequency signal will be produced only when the local oscillator is operating.

There are a number of different dynamic checks for the converter tube in the following experimental procedure. Some of them check only the mixer portion of the tube; others check only the oscillator portion of the tube. Only actual reception of broadcast-band signals, either from a test oscillator or broadcast station, is a dynamic test of both the mixer and oscillator sections of the converter stage.

Procedure.

Step 1. Remove the r-f amplifier tube to prevent signals from entering the converter stage via the antenna.

Step 2. Turn on the receiver and allow the tubes to warm up. Set the volume control to its midposition.

Step 3. Hold a screwdriver by the insulated handle and touch the metal tip of the screwdriver to the signal grid (pin 8) of the converter tube. What is heard in the loudspeaker? Does this indicate that the converter tube is operating?

Step 4. Cover the converter tube with a cloth to protect you from the heat and pull it out. (Be careful, its hot!) Put the r-f amplifier tube back in. When it has heated up, move it in and out of the socket quickly several times. What do you hear in the loudspeaker? Does this indicate that signal is passing through the converter tube? How reliable is a click test based on putting the preceding tube in and pulling it out of the socket?

Step 5. Remove the r-f amplifier tube again and put back the converter tube.

Step 6. Connect your clip lead to the grid (pin 8) of the converter tube; and extend the lead away from the chassis.

Step 7. Rotate the tuning dial over its range. What is heard in the loudspeaker? What does this test tell about the condition from the converter grid to the loudspeaker?

Step 8. Remove the clip lead, and replace the r-f amplifier tube.

Step 9. Adjust the signal generator to deliver a modulated r-f output at 455 kc. Connect the signal generator to the plate of the converter tube.

Step 10. With the volume control set at maximum, adjust the RF ATTEN control of the signal generator until the sound in the loudspeaker is just barely audible.

Step 11. Set the tuning dial at a quiet spot on the dial, or remove the r-f amplifier tube.

Step 12. Move the signal generator cable to the grid of the converter tube. Is there an increase in sound output from the loudspeaker? Reduce the RF ATTEN control setting until the sound from the loudspeaker is again barely audible. The difference between the two settings of the RF ATTEN control is a measure of the gain of the stage. In this case, the gain of the 6SA7 as a straight amplifier is being measured. Also, the mixer portion of the converter tube is now being tested. A 455 kc signal will go through the converter tube, if the mixer portion of the tube is functioning, regardless of whether or not the oscillator is operating.

Step 13. Change the frequency of the signal generator output to any convenient r-f frequency--say 1,000 kc, and tune the receiver dial to this same point. If this point is not a quiet spot, change the signal-generator frequency and tuning-dial position until a quiet spot is found.

Step 14. Reconnect the signal generator cable to the plate of the converter tube. Adjust the RF ATTEN control to obtain barely audible output from the speaker, with the volume control at maximum.

Step 15. Again transfer the signal generator cable to the grid of the converter tube. Is there an increase in the sound output of from the loudspeaker? Reduce the RF ATTEN control setting until the sound output is again barely audible. The difference between the two settings of the RF ATTEN control is the measure of the gain of the stage. Now, the gain of the 6SA7 as a converter is being measured, because we are applying a 1,000 kc signal and measuring the relative amount of 455-kc intermediate frequency signal produced in the output of this stage. Also, the operation of the oscillator is now being checked. Only when the oscillator section of the converter tube is functioning will an r-f signal go through the receiver; that is, the r-f signal interacts with the oscillator output and is converted to the intermediate frequency.

EXPERIMENT 40-4

To learn the dynamic checks for the r-f amplifier stage.

Procedure.

Step 1. At the grid of the r-f amplifier, disconnect the wire from the tuning capacitor to the grid of the r-f amplifier tube. Tune the receiver dial to the extreme low end of the band.

Step 2. Holding an insulated screwdriver by the insulated handle, touch the metal tip of the screwdriver to the grid of the r-f amplifier tube. What is heard in the loudspeaker? What does this tell you about the r-f tube itself and the plate circuit of this tube?

Step 3. Reconnect the wire to the grid of tube.

Step 4. Set up the signal generator to some convenient broadcast frequency, say 1,000 kc, and set the receiver tuning dial to the same frequency.

Step 5. Connect the signal generator to the plate of the r-f tube and the chassis. Turn the modulation on. Adjust the RF ATTEN control of the signal generator until a bare-

ly audible note is heard in the loudspeaker with the volume control at maximum.

Step 6. Move the signal generator to the grid of the r-f amplifier tube. Is the sound in the loudspeaker louder? Reduce the RF ATTEN control until the sound is again just barely audible. Judging by the difference in the two settings of the RF ATTEN control and by the increase in loudness, is the r-f stage amplifying?

Remember the amount of amplification and the increase in sound produced by the r-f amplifier tube for future troubleshooting purposes. Also, note how much r-f signal input, in terms of the RF ATTEN control setting, is needed to give a barely audible signal out of the loudspeaker.

EXPERIMENT 40-5

To troubleshoot the converter stage.

Procedure.

Step 1. In order to simulate an open oscillator coil, disconnect the lead between the oscillator coil and chassis.

Step 2. Turn on the receiver and allow the tubes to warm up. How is the operation of the receiver affected?

Step 3. Measure all the electrode voltages of the converter tube. Are there any departures from normal? What does the high cathode voltage indicate?

Step 4. Touch the tip of a screwdriver to the grid of the converter tube. Is there any response in the loudspeaker? Why?

Discussion. An open circuit in the oscillator coil at this point produces a high positive voltage at the cathode. The normal d-c voltage at this point is zero. The click test of touching a screwdriver to the grid of this tube produces no response in the loudspeaker. This defect, which at first may seem to disable the oscillator only, actually disables the entire converter stage. Because of the location of the open circuit in the oscillator coil, the cathode circuit of the con-

verter is also open, cutting off electron flow through this tube. Thus, no signal of any kind is able to pass through. A click test, or i-f signal injection test of the i-f amplifier stage will show that the i-f stage is operating, thus localizing the trouble to the converter stage. Once the trouble has been localized, d-c voltage measurements point to a defect in the cathode circuit of the converter, and the open coil is quickly located by means of resistance measurements.

Step 5. Reconnect the oscillator coil, and open the oscillator coil at the junction of capacitor C_8 and the oscillator coil L_2 .

Step 6. Turn on the receiver and allow the tubes to warm up. How is the operation of the receiver affected? Turn the volume control to its maximum position. Note the rushing noise. This is characteristic of oscillator trouble. The entire receiver from r-f amplifier to the output section is alive, but broadcast signals cannot be received due to the inoperative oscillator.

Step 7. Try the click test (touching a screwdriver tip to the grid) on the r-f amplifier and converter stages. What does the response in the loudspeaker indicate?

Step 8. Connect the signal-generator cable across the oscillator grid resistor. Set the RF ATTEN control for maximum r-f output. Adjust the tuning dial of the signal generator over the range from about 1,000 kc to 2,000 kc. Turn the generator tuning dial slowly while you listen carefully to the output of the loudspeaker. What happens when the signal generator replaces the oscillator in the receiver? Does this prove that the trouble is in the oscillator section? What would happen if this test were tried with the oscillator coil open as in the previous experiment?

Discussion. When the signal from an r-f generator replaces the defective local oscillator in a receiver, reception is usually restored, thus localizing the trouble to the oscillator portion of the receiver. However, if this test were tried with an oscillator coil open so as to open the cathode circuit of

the converter tube, no results would be obtained. This points out that voltage checks of the stage should first be made. Only when no defects can be located through voltage measurements should the signal-generator replacement method be used.

Step 9. Replace disconnected wiring. Open the oscillator grid resistor.

Step 10. Turn on the receiver and allow the tubes to warm up. What is the effect on the operation of the receiver? What dynamic checks have you learned that could be used to isolate this trouble?

Step 11. Reconnect the grid resistor and temporarily short out the oscillator section of the tuning capacitor with your clip lead. How is the operation of the receiver affected?

EXPERIMENT 40-6

To troubleshoot the r-f amplifier stage.

Procedure.

Step 1. To simulate a defective r-f amplifier stage, remove the r-f amplifier tube.

What dynamic checks have you learned that could be used to localize this trouble?

Step 2. Connect your clip lead to the grid of the converter tube and extend it away from the chassis. Tune the receiver over its range and note the effect in the loudspeaker. Leave the tuning dial set so that the receiver is tuned to a station.

Step 3. Remove the clip lead and put your finger on the grid of the converter tube. Considerable signal pickup should be obtained, except in very weak signal areas. What indication does this test give?

Step 4. Connect a 270- μmf capacitor from grid pin to plate pin of the r-f tube socket.

Step 5. Turn on the receiver and allow the tubes to warm up. What is heard in the loudspeaker? Does this localize the trouble to the r-f amplifier tube?

Step 6. Remove the $270\mu\text{f}$ capacitor. Disconnect at the grid of the r-f amplifier tube the wire between this grid and the stator lug of the r-f section of the tuning capacitor. Dress the lead so that it does not short.

Step 7. Replace the r-f amplifier tube in its socket; turn on the receiver and allow the tubes to warm up.

Step 8. Put your finger on the insulated body of the cathode resistor for the r-f tube and tune the receiver. What is the effect?

Step 9. Hold the r-f amplifier tube with your fingers and tune in the receiver. What is the effect?

In both cases considerable signal pickup should be obtained. Both of these effects are characteristic of the symptoms produced by open antenna coils.

Step 10. Reconnect the disconnected wiring. Disconnect the wire between the ground end of the antenna coil and the AVC line.

Step 11. Turn on the receiver and allow the tubes to warm up. How is the operation of the receiver affected? Replace the wiring.

Discussion. Opening the antenna coil near the ground end produces a different effect

than in the case where the open circuit is at the high end of the coil. Almost the entire coil is connected to the grid, and signals induced in the coil are applied to the grid of the tube. However, because of the open circuit, any hum voltages present in this circuit cannot be grounded out. Thus, the signals heard when the antenna coil is open are distorted. In strong signal areas, grid blocking may occur. This is due to electrons that are drawn to the grid by the positive peaks of strong signals but that cannot leak off due to the open grid circuit.

Step 12. Connect a 12-inch piece of hookup wire to the antenna terminal of the antenna coil. Wrap the insulated hookup wire around the i-f tube. What is the effect on the operation of the receiver?

Step 13. Repeat with the hookup wire wrapped around the first audio amplifier tube. (Remove the tube shield.)

Discussion. Motorboating is produced due to feedback into the input stage. For best operation of the ferrite-rod antenna coil, a short length of wire, about 12 inches, should be left connected to the antenna terminal of the coil and extended away from the chassis. As we have demonstrated, care should be taken to carefully dress this wire away from other tubes on the chassis.
